DR. JESSICA N. BYRAM (Orcid ID : 0000-0001-7097-8352)

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Investigating Student Perceptions of a Dissection-Based Undergraduate Gross Anatomy Course using Q Methodology

Jessica N. Byram,[1] Jason M. Organ,[1] Michael Yard,[2] Naomi A. Schmalz[1]

[1]Department of Anatomy and Cell Biology, Indiana University School of Medicine, Indianapolis, Indiana

[2]Department of Biology, Indiana University-Purdue University, Indianapolis, Indiana

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*Correspondence to: Dr. Jessica Byram, Department of Anatomy and Cell Biology, Indiana University School of Medicine, 635 Barnhill Dr., MS-5035, Indianapolis, IN 46202. USA. E-mail: jbyram@iu.edu

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ABSTRACT

The demand for upper-level undergraduate dissection-based anatomy courses is growing, as professional programs require more advanced anatomy training prior to matriculation. To address this need, Indiana University School of Medicine (IUSM) partnered with Indiana University-Purdue University Indianapolis—a large, urban, life science-focused campus nearby to IUSM—to offer an undergraduate, dissection-based course in regional gross anatomy. Because this is a new course, a deeper post-course evaluation of student perceptions was conducted using Q methodology. In this study, Q methodology was used to evaluate student views of the overall course structure, pre-laboratory materials and activities, assessments, and quality of instruction. Of the 15 students in the spring semester 2018 cohort, 80% (n=12) participated in the evaluation, and 10 of those students followed up with written explanations for their rationale in selecting the four statements with which they most strongly agreed and disagreed. The Q methodology sorted the students into one of three statistically significant groups: Motivated Dissectors (n = 6), Traditional Students (n = 3), and Inspired Learners (n = 3). Motivated Dissectors and Inspired Learners felt strongly that the course did not encourage self-directed learning and that the pre-laboratory materials were not adequate to prepare them for quizzes. Traditional Students, however, disagreed, having a favorable opinion of the pre-laboratory materials, even though this group felt most strongly that the amount of material covered in the course was overwhelming. This study demonstrates the utility of Q methodology to evaluate courses to elucidate student perspectives and inform future course modifications.

Key Words: gross anatomy education, undergraduate education, Q methodology, dissection-based, lecture-free, course evaluation

INTRODUCTION

Introductory undergraduate anatomy courses are offered in a variety of formats organized into regional or systemic approaches, and using a variety of teaching modalities: didactics, nonhuman vertebrate dissection, human cadaver prosection or dissection, computer-assisted learning, flipped-classroom, and other active learning strategies (Wright, 2012; Simpson, 2014; Attardi et al., 2016; Shaffer, 2016). Each of these modalities is used to increase student engagement in the course material. Ultimately, using any of these modalities may answer the American Association for the Advancement of Science (AAAS) call to develop teaching strategies that increase student engagement in undergraduate biology courses (Brewer and Smith, 2011).

The demand for upper-level undergraduate anatomy courses that expand on the learning gained in introductory courses described above is growing as many health professional programs begin to require such courses as requisite for matriculation in their programs (Wright, 2012). Undergraduate cadaveric dissection courses can give advanced-level students a broader application of anatomy and advanced preparation for graduate anatomy coursework (Simpson, 2014). Furthermore, cadaveric dissection is regarded as the premier method for imparting anatomical content (Patel and Moxham, 2008; Kerby et al., 2011) and as a hands-on approach that actively engages students in human anatomy (Heylings, 2002).

To address the need for advanced-level gross anatomy experiences for students matriculating in health professional programs (e.g., physical therapy), Indiana University Purdue University Indianapolis (IUPUI) offers a lecture-free, dissection-based human cadaveric anatomy course for advanced-level undergraduate students. The course—Biology N461—has been taught twice, once each during the spring semesters of 2017 and 2018. Based on completed course evaluations, the first two student cohorts had overwhelmingly positive perceptions of the course. Yet, because this course is new, instructors wanted to examine student perspectives of the course in more detail and depth than provided by IUPUI institution-generated course evaluations. Q methodology was used to achieve this goal. The results of the Q methodology evaluation of the course performed at the end of the 2018 spring semester are presented here. These results are important locally. However, presentation of the Q methodology results for this course specifically is *not* the ultimate purpose of this study. Instead, this study explicitly demonstrates the utility of using Q methodology to evaluate courses to elucidate deeper student perspectives and feedback than is possible with typical institution-generated course evaluations.

William Stephenson developed Q methodology in 1935 as a technique to measure subjectivity (Stephenson, 1953; Ramlo, 2012). Subjectivity in this context is an individual's communication of his or her point of view (McKeown and Thomas, 1988) and Q methodology portends all subjectivity is transformable into a factor structure (Stephenson, 1980). Q methodology combines the strengths of both quantitative and qualitative methods by providing a systematic approach to investigating individual perspectives that are often lost in quantitative analyses (Brown, 1993). Simply stated by Coogan and Herrington, Q methodology allows the researcher to "capture the essence of what the participants feel about a topic from collective voices, while at the same time identifying subtle differences between some of these voices” (Coogan and Herrington, 2011). Since its inception in the field of academic psychology, Q methodology has been used in studying subjectivity in the fields of communication, marketing, and political science (Cross, 2005) but is more recently being used in the fields of education (Ramlo 2012), program evaluation (Ramlo et al., 2008; Baptiste, 2010), and health sciences (Cross, 2005; Akhtar-Danesh et al., 2008).

Q methodology asks participants to evaluate a set of statements and to determine the significance of those statements from the participant’s perspective. Participants are then grouped based on their commonalities. Q methodology involves three procedures: (1) generation of a Q set or sample; (2) completion of a Q sort by participants; and (3) factor analysis of the completed Q sort (Watts and Stenner, 2005).

The Q set contains a numbered list of statements that may characterize an individual’s perspective or opinion about a particular topic. Participants rank the statements based on the extent to which they agree or disagree with them and place them into a table called a Q sort (See Figure 1). At one end of the Q sort, the participant places statements that they disagree with the most; they place statements with which they strongly agree at the other end (Watts and Stenner, 2005). Participants are encouraged to begin the Q sort by selecting the items they feel most strongly about, positive or negative, and placing a “+5” or “-5” next to that statement, respectively. Participants continue to rank statements with values as they correspond to the number of boxes allotted for those values in the Q sort table (e.g., three “+4” and “-4”, four “+3” and “-3”, etc.). In the end, participants will have ranked all items in the Q set and then can transcribe the item number into the corresponding column of the Q sort table based on rank (Figure 1). Each item can only be placed in one box and every item must be used.

Currently, only a handful of programs exist with the capability for Q methodology, by-person factor analysis (Akhtar-Danesh, 2018). Unlike ordinary factor analysis, in Q methodology the factor analysis is used to calculate correlation coefficients between sorts (i.e., participants) to identify common viewpoints among individuals (Jurczyk and Ramlo, 2004). Q sorts that correlate significantly are grouped into factors and each factor represents a group of individuals with similar perspectives related to the theme of the study (Aktah-Danesh et al., 2008). Two extraction methods exist, centroid method and principal component analysis (PCA), where the centroid method provides a potentially infinite number of rotations and PCA provides a single, correct solution. Furthermore, a researcher can rotate factors using a manual or varimax technique where the manual rotation is based on theoretic judgment (e.g., grouping based on demographics, etc.) and the varimax technique maximizes variation explained by the factors (McKeown and Thomas, 1988; Watts and Stenner, 2005).

Using Q methodology to evaluate a course provides different data than traditional, Likert-type evaluations because it allows students to provide their perspectives about a course and rank aspects of the course based on their preference. Traditional course evaluations are aimed at providing summative results of students' opinions about a course but fail to consider individual students' perceptions. Furthermore, they do not account for the relative importance of the items being measured (Jurczyk and Ramlo, 2004; Brandl et al., 2017). While traditional course evaluations typically contain a limited number of questions for qualitative written responses, these comments are not often sufficiently analyzed by instructors (Gravestock and Gregor-Greenleaf, 2008). Due to the statistical analysis component, Q methodology is often regarded as a more rigorous technique for evaluating perspectives (Aktah-Danesh et al., 2008). Q methodology has been used successfully for course evaluations to compare students' unique perspectives about the course, and therefore has the ability to inform areas of improvement in future courses (Ramlo et al., 2008).

The purpose of the present study, as described above, was to investigate the utility of Q methodology to evaluate students' views of the overall course structure, activities, assessments, and quality of instruction. A Q set was created that contained a list of items that were considered to be a potential answer to the following question: "How do students perceive the cadaveric human anatomy course?" It is hypothesized that the results of the Q methodology course evaluation will demonstrate students' nuanced perceptions of the course.

MATERIALS AND METHODS

Course Design and Overview

The advanced undergraduate *Cadaveric Human Anatomy* course (IUPUI BIOL N461) is a partnership between Indiana University School of Medicine (IUSM) and Indiana University-Purdue University, Indianapolis (IUPUI). Indiana University School of Medicine and IUPUI share an adjoining campus in downtown Indianapolis, Indiana. IUSM provides cadavers and dissection facilities to students in the course who are drawn from the large population of undergraduate and pre-professional students at IUPUI. Students who have enrolled in the course to date are primarily biological science majors or students who intend to advance into health professional programs (nursing, pre-physical therapy, pre-medicine, etc.). The five-credit hour course does not offer any formal lectures; instead, all course activities take place in the IUSM gross anatomy laboratory. The 16-week course is divided into four regional blocks: (1) Thorax and Abdomen, (2) Back and Upper Limb, (3) Pelvis and

Lower Limb, and (4) Head and Neck. Each block culminates in a 50-item practical examination tagged on cadavers, models, and bones. The course meets twice weekly for 3 hours of dissection and the students spend approximately 80 hours in the gross anatomy laboratory across semester. Students have several pre-laboratory activities that require completion before each meeting including reading handouts and textbook chapters and completing a five-item quiz. Students are assigned to a table of 4-5 students for the entirety of the semester. A grade of "B" or better in an entry-level human anatomy course (IUPUI BIOL N261 or equivalent) is required as a pre-requisite to enroll in this course. The course was an elective so only students who wanted to enroll in the course did so.

Course Materials

Each laboratory session has a corresponding handout that includes objectives for the session, dissection instructions, relevant clinical and functional correlations, and a structure identification list. In addition, the handouts contain detailed information about the structures to be identified in that session, including their anatomical relationships, associations, and functions. Handouts are created to synthesize relevant information and to reduce the amount of extraneous information included in graduate-level dissectors, which are far beyond the scope of an undergraduate gross anatomy course. Dissection instructions are incorporated throughout the handout as detailed information is provided about structures and their relationships; students are expected to bring a copy of the handout to each laboratory session.

The textbook used in the course is *The Big Picture: Gross Anatomy* (Morton et al., 2011) which provides students with the information necessary to successfully complete a gross anatomy course while minimizing minutiae. Students are assigned chapters corresponding to the region of dissection, and specific images from those chapters are referenced in the laboratory handouts to provide students with additional context.

The final pre-laboratory activity requires students to complete a 5-item quiz assessing content for the upcoming laboratory session prior to the scheduled dissection. Questions are drawn from pre-laboratory materials (handout and textbook chapters) and are predominantly first-order questions requiring the students to recall, understand, and describe anatomical structures, associations, functional relationships, and the anatomical basis of clinical conditions. Quizzes are administered via Instructure Canvas learning management system and students are given 5 minutes to complete each quiz. Students' browsers are locked when taking the quiz to prevent internet searches but they are permitted to use the handout and textbook as necessary to answer the questions. Given the short period to take the quiz, students are strongly encouraged to prepare in advance in order to perform well.

A key component of the course is the use of a prosected cadaver, with appropriate prosected regions available for consultation during that day's dissection period and all other unscheduled study. Each laboratory session begins with a short, 15-20-minute demonstration over the prosected cadaver, and is followed by student dissection of additional cadavers under the supervision of instructors and teaching assistants. Prosection demonstrations provide an overview of dissection instructions, demonstrate key structures and anatomical relationships, and provide time to address student questions and concerns prior to dissection.

Prosection demonstrations are projected from an overhead camera to several television screens throughout the laboratory. Audio is broadcast over the laboratory public address system, and audio and video signals are recorded and embedded into a Canvas page corresponding to that laboratory session. Embedding the recording allows access to the demonstration but prevents downloading of the file, maintaining the file behind an internet firewall.

The last laboratory session prior to an exam includes a brief dissection and structured review time with instructors. This review includes a 10-15 item practice practical examination using the prosected cadaver, bones, and models that serve as exemplars of the upcoming block examination. Once the students have recorded their answers to the practice exam, the review culminates with a debriefing of each item that allows the instructors to walk through how to respond to the question and pose additional questions about the related structures.

Block examinations are 50-item, timed examinations where students are given one minute and 15 seconds to answer each question. Items are mostly short answer, free response questions with occasional multiple choice or true/false questions. Roughly 35 items (of the 50 total) are tagged on cadaveric material, with the remaining 15 items tagged on models, bones, or presented as written questions. Approximately 75% of questions are first-order questions requiring structure identification and the remaining 25% are higher-order functional or clinical correlate questions.

At the time of manuscript submission, two cohorts have completed the course: 17 students in the spring 2017 semester and 15 students in spring 2018 semester. Each cohort had access to four cadavers for student dissections and one prosected cadaver.

Data Collection

A Q set of statements that broadly represented impressions of the course was created by course instructors based on examination of the literature on course evaluations and informal discussions with students. The Q set was piloted on three students from the spring of 2017 cohort to ensure the statements were clearly expressed and adequately covered a range of students' perceptions of the course. The final Q set included 43 randomly assorted statements.

Students enrolled in the spring 2018 cohort of the cadaveric human anatomy course were invited to participate in the Q methodology course evaluation. The evaluation was presented to students on the final scheduled review session of the semester as a voluntary and anonymous activity to provide course instructors with actionable plans to improve the course. Students were provided with paper copies of an empty Q sort table (Figure 1), a Q set with the 43 statements, and instructions to complete the Q methodology course evaluation. Additionally, the students were given four qualitative free-response boxes to provide rationale for why they selected their two statements as "-5" and two statements as "+5" (see Appendix A).

All instructors left the room while the students completed the course evaluations and one undergraduate teaching assistant remained to answer questions and collect completed Q sort tables and qualitative responses. It took students an average of 20 minutes to complete the Q sort evaluation. Q sorts and qualitative responses were not returned to the instructors until final grades were submitted to the school. Due to the heterogeneous nature of the small student population and the desire for responses to remain anonymous, no demographic information was collected from students. This study was granted exempt status by the Institutional Review Board of IUSM (protocol number 1804247884).

Data Analysis

All Q sort data were analyzed with the PQMethod v. 2.35, a dedicated Q methodology program (Schmolck, 2018). Watts and Stenner (2005) recommend using a dedicated Q methodology package and PQMethod is an effective program that freely downloadable from the internet. Paper Q sorts were manually entered into the program and a factor analysis was performed. Factors were extracted using Horst's centroid method, which allowed the program to determine the optimum number of factors to extract. Three factors emerged from the data and a varimax rotation was used to rotate those factors, as there was no theoretical reason to manually rotate. The program flagged individual sorts to indicate they defined those factors. Only those sorts flagged for a factor were used in this analysis.

The final stage of analysis produces a variety of tables on factor loadings, statement factor scores, and discriminating statements for each factor. Factor loadings are essentially correlation coefficients in that they indicate the extent to which each sort is similar or different from the best estimate or model Q sort for that factor. While a factor is defined by the individuals who load highly on the factor (Schmolck, 2014), interpretations are based primarily on factor scores. Factor scores indicate the magnitude to which certain viewpoints are associated with one particular factor over another. They are computed as z-scores, but are converted into whole numbers based on the sort position (-5 to +5) to simplify comparisons between factors. Factor scores can then be compared to determine the items that are discriminating or placed in significantly different locations on the Q sort for any two factors (McKeown and Thomas, 1988).

Qualitative responses were transcribed and categorized by Q set statement number and rank (+5 or -5). Responses were then used to provide context to the results of the Q methodology factor analysis.

RESULTS

Twelve of the 15 students who participated in the spring 2018 course (n = 12, 80%) completed the Q sort table. Ten of those students (n = 10, 67%) provided written responses explaining their rationale for selecting the four statements with which they most strongly agreed and disagreed. The first factor consisted of six students and the second and third factors each consisted of three students (Table 1).

Students in Factor 1 were labeled as “Motivated Dissectors” in that they felt supported in the laboratory environment, considered dissection to be an important component of their learning (+5 sort positions), and learned a lot in the course (+4 sort position). Although these students did not think that the lack of lecture impeded their learning or that there were unclear learning expectations (-5 sort positions), they also did not feel that the course encouraged self-directed learning or that the textbook was appropriate for the course (-4 sort positions; Table 2).

Students in Factor 2 were labeled as “Traditional Students” because while they agreed they learned a lot in the course and that the course increased their interest in anatomy (+5 sort positions), they thought the prosection demonstration videos were effective study tools (+4 sort position). Similar to the Motivated Dissectors, Traditional Students found that learning expectations were clear and that the book was inappropriate for the course (-5 and -4 sort positions, respectively). They also found that the pre-laboratory materials were not helpful for learning content matter and that there was not enough time to complete laboratory exercises (-5 and -4 sort positions, respectively; Table 3).

Students in Factor 3 were labeled as “Inspired Learners” as they generally approved of the course, finding that they learned a lot and that it increased their interest in anatomy (+4 sort positions) and desire to enter a health professional field (+5 sort position). However, these students did not feel that they developed an ability to work as part of a team or that the pre-laboratory handouts had clear dissection instructions (-4 sort positions; Table 4).

Significant differences between Q sorts indicated that students in the Motivated Dissectors group felt more strongly that the course did not encourage self-directed learning (-4 sort position), or that pre-laboratory materials (textbook and handout) adequately prepared them for quizzes (-3 sort position) than students in the Traditional Student and Inspired Learner groups. Traditional Students disagreed strongly with the Motivated Dissectors and Inspired Learners about the efficacy of pre-laboratory materials in scaffolding their learning of anatomy content (-5 sort position). Traditional Students did feel that these materials helped them prepare for quizzes (+3 sort position). Furthermore, Traditional Students felt more strongly than the other students that the amount of information covered by the course was unreasonable for the course level (-4 sort position) and that the lack of formal lecture impeded their learning (-3 sort position). The Inspired Learners were the only students who held a favorable opinion regarding the appropriateness of the textbook (+3 sort position). However, they held relatively unfavorable opinions about the pre-laboratory demonstrations compared to the other students; they did not feel that the demonstrations covered an appropriate amount of content (-4 sort position) and did not consider them to be effective study tools (-1 sort position; Table 5).

Qualitative responses were overwhelmingly positive with regard to receiving clear expectations from instructors and the lecture-free format of the course. One student stated, *"This is the first lab I've taken without the lecture component and I really enjoyed it. The perfect blend of pre-lab information/demonstration and hands-on approach was very efficient [for] teaching the material*." Responses also helped to clarify some of the negative perceptions around the pre-laboratory materials in particular. Several students found the quizzes to be stressful because of the limited amount of time they were given to complete them. One student stated, "*The [quizzes] stressed me out and didn't add anything but points to my grade*." Others considered the pre-laboratory handouts to need improvement; they suggested that the pre-laboratory materials and dissection instructions should include more images.

DISCUSSION

The purpose of this study was to investigate the use of Q methodology to evaluate student perceptions of a novel, lecture-free undergraduate cadaveric human anatomy course and to determine which aspects of the course design and delivery students found to be most effective. More importantly, this study demonstrates the utility of using Q methodology to improve curriculum quality above and beyond what is possible with traditional course evaluation. The Q methodology course evaluation was created with a set of Q set statements tailored to address each aspect of the course design in an effort to explore the entire scope of the students' perspectives of the course. Furthermore, course evaluations solicited by the institution primarily evaluate the quality of instruction rather than assessing the course itself.

Likert-type evaluations provided to students are usually in the form of students' evaluations of teaching (SET). These evaluations are used, at least in part, for promotion and tenure decisions (Ramlo, 2017), but also to provide faculty with feedback to improve teaching. The instruments vary across institutions in terms of the items and coverage and may or may not contain items specifically aimed at evaluation of the course rather than the instructor (Marsh, 2007). Furthermore, Likert-type evaluations are relatively poor at discriminating among students' subjective opinions about a course, and unless students provide constructive qualitative comments, these evaluations provide little in terms of guiding actionable improvements for the course (Jurczyk and Ramlo, 2004). Using Q methodology for course evaluation provides instructors with descriptive results of the varying student views of the course (Ramlo, 2017).

The goal of this Q methodology course evaluation was to determine whether the approach could elicit nuanced perspectives about the course to inform course modifications and improvements based on students' views. Course improvement through evaluation allows the instructor to make decisions regarding where changes are needed to instructional materials and methods. Student attitudes are among the outcomes of concern with course evaluation and should be taken seriously when there is a commonality of undesirable opinions about a particular aspect of the course (Cronbach, 2000). The Q methodology course evaluation was an effective method of evaluation because it elicited students' opinions and allowed the instructors to identify commonalities between the multiple student views of the course. This evaluation allowed instructors to make informed decisions based on the literature to improve the course for future students, as demonstrated in the subsequent paragraphs.

Students' perceptions of the course being lecture-free were overwhelmingly positive. Overall, the sorting position for the Q set statement: "The lack of formal lecture impeded my learning," was negative (-5, -3, and -5 for Factors 1, 2, and 3, respectively). Previous literature suggests that science students are reluctant to take courses that replace lectures with active learning methods over courses that do offer lectures as the learning modality (Welsh, 2012). Students in this study stated that lecture may detract from the time they needed to do "hands-on" learning in the laboratory. However, the students who enrolled in this course and subsequently evaluated it are a group of highly motivated students precisely because they undertook this difficult course of their own volition. The lecture-free environment may have fostered a sense of autonomy resulting in increased enthusiasm about the structure of the course (Burgess and Ramsey-Stewart, 2014).

Anatomists have long debated the effectiveness of cadaveric dissection in learning gross anatomy (McLachlan et al., 2004; Ghosh, 2017; McMenamin et al., 2018; Wilson et al., 2018). Cadaveric dissection was chosen as the primary learning modality in this course because it engages the student in active and self-directed learning while demonstrating authentic human anatomy (McMenamin et al., 2018). Dissection is clearly a valuable tool for learning; however, dissection cannot be a solitary learning experience and needs to be complimented with other learning materials (Ghosh, 2017). Thus, careful thought and consideration went into the creation and selection of pre-laboratory materials to scaffold learning and prepare students for dissection. The results of the Q methodology course evaluation (informed by constructive written responses) indicate that instructors should re-evaluate several of the pre-laboratory activities, a process that is ongoing as we teach the Spring 2019 cohort.

The Motivated Dissectors did not consider the pre-laboratory handouts to have clear dissection instructions and the Traditional Students did not consider them helpful in learning the subject matter. Some students commented that the organization of the handouts may have contributed to their inadequacy. The dissection instructions are interspersed throughout the document among detailed information about structures. Because checklists are effective in the gross anatomy laboratory to assist students in maintaining focus during dissection (Hofer et al., 2011), for future courses, all dissection instructions will be extracted and placed in a checklist format at the beginning of the handout for clarity. Brief statements about important relationships (e.g., "Reflect pectoralis major from its attachments on the costal cartilage, sternum, and medial clavicle. Be cautious not to damage the lateral pectoral nerve and pectoral artery running on its inferior surface at the superior border") will be included in the dissection checklist, but detailed information about structures, functions, and relationships will be placed in a logical order following the checklist.

Students did not find the pre-laboratory materials to be helpful for quiz preparation. This was quite concerning because quiz questions were formulated almost exclusively from the information presented in the handouts. Despite the fact that quizzes were designed to encourage students to study the material before class (McKenzie, 1973), it is possible that students were not preparing adequately and therefore felt constrained by the time limit. One method used to motivate students to prepare for class activities in advance is to provide them with structured exercises to complete following their reading assignments (Yamane, 2006). These structured activities assist the students in scaffolding information from the reading and may help them to feel more prepared for quizzes compared to when they do not use these activities alongside completing assigned readings. Several other structured activities could be integrated in the handouts including, for example, questions, tables, concept maps, and diagrams in order to assist the students in synthesizing information prior to taking quizzes.

Several comments were received regarding the quiz schedule, timing of the quizzes, and quiz format. In particular, a couple of students commented that having to complete a quiz prior to each laboratory setting was inconvenient, while others flatly disliked the quizzes. Quizzes taken prior to pre-class activities have been shown to improve examination performance (Narloch et al., 2006) and encourage reading of materials prior to class (McKenzie, 1973). However, some suggest that frequent quizzing can increase anxiety and decrease performance (McKenzie, 1973; Nguyen and McDaniel, 2015). The quizzes will remain a vital component to ensure prior preparation. However, these results suggest the schedule, timing, and condensing of quizzes may reduce quiz fatigue.

Students had mixed feelings about the appropriateness of the textbook for the course. Instructors found the textbook to cover the right amount of material at a suitable level of detail for undergraduate students. Interestingly, students may have considered it to be *too* simplified and desired a textbook with greater scope and detail. In the future, additional textbooks and readings will be suggested for those students interested in learning more about particular topics with the caveat that they are only responsible for content presented in the required textbook.

Finally, the Traditional Students felt strongly that they did not have enough time to complete laboratory exercises during scheduled class time. Each laboratory session was modified from a medical-level gross anatomy course, although the content and number of structures to identify were drastically reduced. Instructors considered three hours to provide an ample amount of time to complete each dissection. However, the students were novice dissectors and some, even toward the end of the semester, lacked adequate dissection skills to complete dissections in a timely manner. This perceived lack of time may have been further complicated by the disorganized dissection instructions. Adding dissection instruction checklist may ameliorate some time constraints by streamlining dissection objectives (Hofer et al., 2011).

Limitations of this study

This study is limited in part by small size, even though it is accepted that Q methodology does not require a large number of participants to be effective and meaningful (Watts and Stenner, 2005). In fact, given the high response rate for the present study (80%), the results are likely to accurately reflect perspectives of students in the course. Furthermore, adding an additional cohort of students to increase the sample size and perceived generalizability of the findings is not the goal of this study and doing so could negate the subtle nuances in the data (Watts and Stenner, 2005).

A bigger limitation, although one that is true of all studies that use Q methodology, is that the specific results of the present study are not generalizable to other institutions or similar courses. In fact, it is the main take-home point of this study that Q methodology is an effective approach to drill down deeper into student perceptions and capture nuanced perspectives among a specific group of learners within the context of a single course, in order to make modifications to address these perspectives in future iterations of the course. Instructors in BIOL-N 461 intend to implement suggestions made by students in the 2018 cohort and will continue to use Q methodology to evaluate student perceptions of course each year.

CONCLUSIONS

Two cohorts of students have now completed the upper-level, undergraduate, dissection-based gross anatomy course at IUSM and IUPUI. Students from the second cohort were invited to reflect on their experiences during the course through Q methodology evaluation at the end of the semester. Q methodology proved to be a valuable tool to investigate individual students' perception of the course and will allow for revision of existing course resources and implementation of new ones with past student perceptions in mind.

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NOTES ON CONTRIBUTORS

JESSICA N. BYRAM, Ph.D., is an assistant professor of anatomy in the Department of Anatomy and Cell Biology at Indiana University School of Medicine, Indianapolis, IN. She teaches histology, embryology, and gross anatomy to undergraduate, graduate and medical students, and her research interests include professional identity formation and medical professionalism.

JASON M. ORGAN, Ph.D., is an assistant professor of anatomy in the Department of Anatomy and Cell Biology at Indiana University School of Medicine, Indianapolis, IN. He teaches gross anatomy and science communication to medical, graduate, and undergraduate students. His research interests include musculoskeletal biomechanics, evolution, and effective science communication.

MICHAEL YARD, M.S., is a senior lecturer of anatomy in the Department of Biology at Indiana University-Purdue University, Indianapolis, IN. He teaches human anatomy and gross anatomy to undergraduate students and his research interests include the possible morphological and neurogenetic links of autism as well as blood biomarkers for suicidality.

NAOMI SCHMALZ, M.S., is a graduate (Ph.D.) student in anatomy education in the Department of Anatomy and Cell Biology at Indiana University School of Medicine, Indianapolis, IN. She teaches anatomical sciences to undergraduate, graduate, and health professional students. Her research interests include community outreach, service-learning, and reflective practices.

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FIGURE LEGENDS:

Figure 1: Q sort table used in this study for the sorting of the statements in the Q set. There are 43 spaces to accommodate the 43 statements in the Q set.

Table 1. Factor Loading Matrix with an X Indicating a Defining Sort

Q Sort	Factor 1	Factor 2	Factor 3
1	0.499X	-0.091	0.257
2	0.077	0.494X	0.136
3	0.618X	-0.038	0.384
4	0.265	-0.115	0.533X
5	0.337	0.210	0.532X
6	0.066	0.152	0.456X
7	0.425	0.694X	0.461
8	0.745X	0.194	0.281
9	0.659X	0.197	-0.019
10	0.0629	0.730X	-0.106
11	0.647X	0.383	0.218
12	0.547X	0.234	0.261
% Var. Exp[a]	23%	14%	12%

[a]The percentage of study variance explained by each factor.

Table 2. Statements Characterizing Factor 1 by Sort Position and Z-Score

No.	Statement	Sort Position	Z-Score
Factor 1: The Motivated Dissector			
39	I felt supported by my instructors in the laboratory environment.	+5	2.030
30	Participating in dissections increased my confidence in course content.	+5	1.831
22	I learned a lot in this course.	+4	1.785
4	Instructors provided sufficient help in the laboratory.	+4	1.571
29	This course encouraged self-directed learning.	-4	-1.043
14	The textbook was appropriate for this course.	-4	-1.205
13	I was unclear of my expectations in this course.	-5	-2.105
36	The lack of a formal lecture impeded my learning in this course.	-5	-2.168

Table 3. Statements Characterizing Factor 2 by Sort Position and Z-Score

No.	Statement	Sort Position	Z-Score
Factor 2: The Traditional Student			
22	I learned a lot in this course.	+5	1.995
24	This course increased my interest in human anatomy.	+5	1.931
43	Prosection demonstrations posted on Canvas were an effective study tool.	+4	1.755
20	Progression of the course was logical from beginning to end.	+4	1.643
14	The textbook was appropriate for this course.	-4	-1.354
1	I had adequate time to complete laboratory exercises during class time.	-4	-1.406
13	I was unclear of my expectations for this course.	-5	-1.466
3	Pre-laboratory materials (textbook, handouts, and quizzes) helped in learning the subject matter.	-5	-1.815

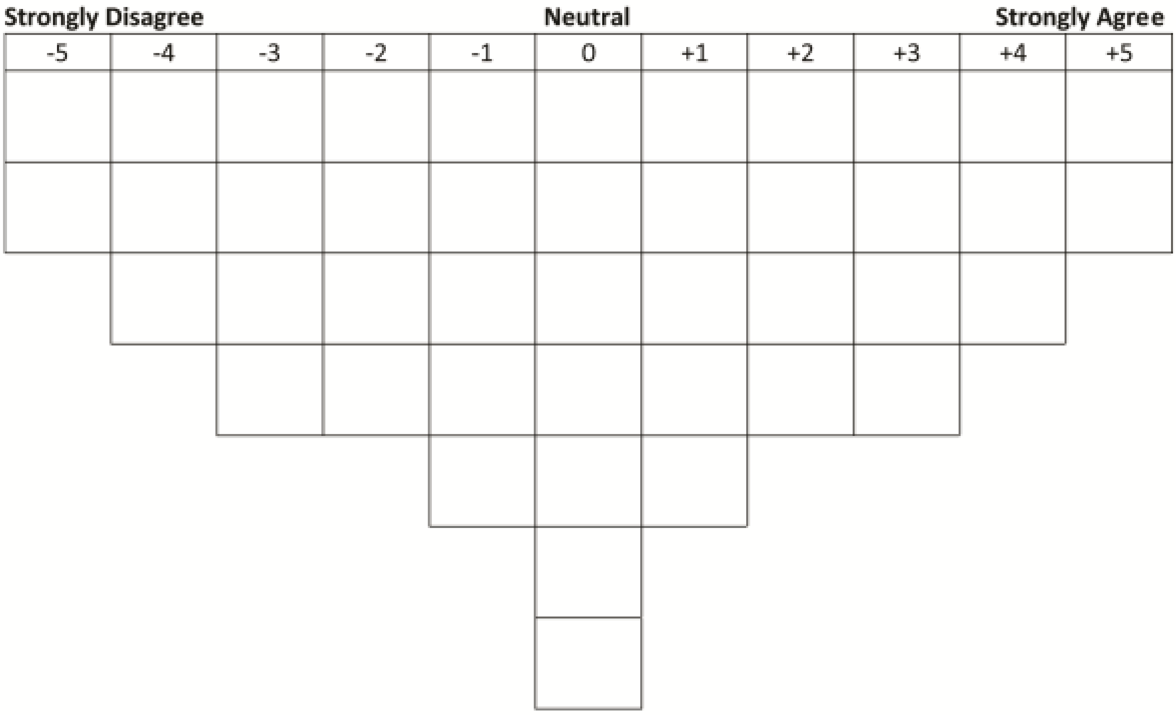
Table 4. Statements Characterizing Factor 3 by Sort Position and Z-Score

No.	Statement	Sort Position	Z-Score
Factor 3: The Inspired Learner			
35	This course increased my desire to enter a health profession.	+5	2.274
4	Instructors provide sufficient help in the laboratory.	+5	1.509
24	This course increased by interest in human anatomy.	+4	1.431
22	I learned a lot in this course.	+4	1.294
28	I developed an ability to work as a part of a team.	-4	-1.394
34	Pre-laboratory handouts provided clear dissection instructions.	-4	-1.470
13	I was unclear of my expectations in this course.	-5	-2.038
36	The lack of a formal lecture impeded my learning in this course.	-5	-2.313

Table 5. Discriminating Statements Demonstrated by Significant Differences in Sort Positions between Factors.

No.	Statement	Factor 1 Sort Position	Factor 2 Sort Position	Factor 3 Sort Position	Z-Score Difference
14	The textbook was appropriate for this course.	-4	-4	3[a]	2.49
20	Progression of the course was logical from beginning to end.	-1	+4[a]	0	2.09
25	Pre-laboratory materials adequately prepared me for quizzes.	-3[a]	+3	0	1.94
36	The lack of formal lecture impeded my learning.	-5	-3[a]	-5	-1.22
29	This course encouraged self-directed learning.	-4[a]	0	0	-1.32
43	Demonstrations posted on Canvas were an effective study tool.	+4	+4	-1[a]	-1.97
12	The total amount of material covered in the course was reasonable for a 400-level course.	+0	-4[a]	+3	-2.03
15	Pre-laboratory demonstrations covered appropriate content.	+3	+1	-4[a]	-2.21
3	Pre-laboratory materials (textbook, handouts, and quizzes) helped in learning the subject matter.	+1	-5[a]	+2	-2.55

[a]Statistically significant at P < 0.01.



Appendix A. Factor Array that demonstrates relative sort position for the entire Q Set.

#	**Statement**	**Factor 1**	**Factor 2**	**Factor 3**
1	I had adequate time to complete lab exercises during class time.	-1	-4	-1
2	This course was organized well.	2	3	4
3	Pre-lab materials (textbook, handouts, quizzes) helped in learning the subject matter.	1	-5	2
4	Instructors provided sufficient help in the lab.	4	0	5
5	The objectives for lab sessions were well defined.	-2	0	-2
6	I kept up with the studying for this course.	-1	0	1
7	I actively participated in lab activities and dissection.	3	2	3
8	Instructors adapted to student abilities, needs, and interests.	1	-1	1
9	Lab sessions were well organized.	2	-3	-1
10	Practice practicals reinforced key concepts.	-1	-1	2
11	I feel that I performed up to my potential in this course.	1	-1	1
12	The total amount of material covered in the course was reasonable for a 400-level course.	0	-4	3
13	I was unclear of my expectations for this course.	-5	-5	-5
14	The textbook was appropriate for this course.	-4	-4	3
15	Pre-lab demonstrations covered content appropriate for this course.	3	1	-4
16	The amount of lab work required in the course was reasonable.	0	-1	-2
17	Instructors related lab exercises to pre-lab materials.	0	-2	-3
18	The objectives of this course were clearly stated.	1	-3	-3
19	Exams were graded fairly.	0	0	2
20	Progression of the course was logical from beginning to end.	-1	4	0

21	Lab instructors clearly explained the procedures to be used.	0	1	-2
22	I learned a lot in this course.	4	5	4
23	Lab sessions were interesting and stimulating.	2	4	0
24	This course increased my interest in human anatomy.	3	5	4
25	Pre-laboratory materials adequately prepared me for quizzes.	-3	3	0
26	Topics covered in the course were well integrated.	-1	1	-3
27	Lab sessions were reasonable in length and complexity.	-3	2	-1
28	I developed the ability to work as part of a team.	-2	0	-4
29	This course encouraged self-directed learning.	-4	0	0
30	Participating in dissections increased my confidence in course content.	5	2	3
31	Exams appropriately reflected course content.	1	-2	2
32	Pre-lab materials (textbook, handouts, quizzes) sufficiently prepared me for lab sessions.	-2	-3	0
33	Quizzes held me accountable to preparing for lab.	-3	-2	0
34	Pre-lab handouts provided clear dissection instructions.	-3	1	-4
35	This course increased my desire to enter a health profession (Medicine, Dentistry, Nursing, etc.).	0	3	5
36	The lack of a formal lecture impeded my learning in this course.	-5	-3	-5
37	Pre-lab demonstrations lasted a reasonable length of time.	-2	-2	-2
38	Practice practicals fairly represented unit examinations.	0	0	1
#	**Statement**	**Factor 1**	**Factor 2**	**Factor 3**
39	I felt supported by my instructors in the lab environment.	5	2	1
40	I could clearly hear and see pre-lab demonstrations.	-4	-1	0
41	The prosection was a useful learning tool.	3	3	-1
42	Interactions with undergraduate TAs enhanced my laboratory experience.	2	1	-3
43	Prosection demonstrations posted on Canvas were an effective study tool.	4	4	-1

Appendix B. Consensus statements that do not distinguish between any pair of factors and differences in sorting position were not significant at p >0.05.

No.	**Statement**	**Factor 1 Sort Position**	**Factor 2 Sort Position**	**Factor 3 Sort Position**
2	This course was organized well.	2	3	4
5	The objectives for lab sessions were well defined.	-2	0	-2
7	I actively participated in lab activities and dissection.	3	2	3
8	Instructors adapted to student abilities, needs, and interests.	1	-1	1
13	I was unclear of my expectations for this course.	-5	-5	-5
16	The amount of lab work required was reasonable.	0	-1	-2
19	Exams were graded fairly.	0	0	2
22	I learned a lot in this course.	4	5	4
24	This course increased my interest in human anatomy.	3	5	4
33	Quizzes held me accountable to preparing for lab.	-3	-2	0
37	Pre-lab demonstrations lasted a reasonable length of time.	-2	-2	-2
38	Practice practicals fairly represented unit examinations.	0	0	1